2.0 GROUNDWATER DATA – COLLECTION AND CONCEPTUAL SITE MODEL

2.1 Data Collection and Literature Search

The data collection and literature search efforts were the first steps taken in conducting the groundwater evaluation. A comprehensive literature search was conducted to identify and obtain published research on Lake Tahoe studies involving geology, hydrogeology, geomorphology, nutrients sources, land use, groundwater modeling, behavior of nitrogen and phosphorous in groundwater, and remediation technologies. Over 300 literature sources were identified, and among those, several were carefully selected and reviewed.

The groundwater evaluation focused on a re-evaluation of existing data and a limited compilation of new data generated since the study conducted by Thodal (1997). The goals for the re-evaluation of existing data were to identify land use practices (current and historic) that could be contributing to nutrient loading to the groundwater system, and to develop an estimate for nutrient loading to Lake Tahoe transported through groundwater. Specific data collected included nutrient concentrations, groundwater flow characteristics, and geology available through records of public drinking water supply wells and groundwater monitoring wells. Other resources used were land use maps, aerial photographs, and Geographical Information System (GIS) layers.

Existing data was obtained from a number of different local, state, and federal agencies in California and Nevada. Among the agencies contacted, many were able to provide data which was valuable to this evaluation. There are still numerous studies currently being conducted in the basin which were not included. Some of this un-finalized data will become available in the near future, but not in time to contribute to this evaluation. Though most data obtained was in electronic form, there was a significant amount presented as hard copies. Some of the more manageable hard copy data was obtained and used in this evaluation. Some data needed to evaluate regional groundwater flow did not exist and additional field work and sample collection will be necessary to fill in those data gaps. In addition, not all land use types evaluated had associated groundwater nutrient data. In this instance, assumptions were made to estimate how specific land use types would affect nutrient loading.

Agencies contacted for data collection and information included but were not limited to the following: Lahontan Regional Water Quality Control Board, Tahoe Regional Planning Agency, University of California-Davis - Tahoe Research Group, University of Nevada-Reno, Desert Research Institute, California Tahoe Conservancy, US Forest Service, US Geological Survey, California Department of Health Services – Data Management Unit, California Department of Water Resources, California State Park Service, Nevada State Health Division, Nevada Division of Environmental Protection, Nevada Division of Water Resources, Nevada Division of State Lands, Public Utility Districts (South Tahoe, Tahoe City, North Tahoe), General Improvement Districts (Incline Village, Kingsbury), City of South Lake Tahoe, El Dorado County Department of Transportation and Environmental Management, Placer County Environmental Management and Transportation Departments, Washoe County, Douglas County, Lake Tahoe Transportation & Water Quality Coalition, South Tahoe Chamber of Commerce, The League to Save Lake Tahoe, Swanson Hydrology and Entrix.

2.2 Historic Aerial Photography

Historical aerial photography was obtained from the U.S. Forest Service. This photography was obtained for Lake Tahoe Basin from 1966, 1968, and 1971. The photography was scanned and geo-referenced to the 1998 digital orthoquad. The developed areas were then determined based on roads and other features representing development. This was then used to determine where there could be septic tank leach fields remaining in the basin. These are important features as they could be continuous sources of nutrients to groundwater in the basin.

2.3 Conceptual Site Model

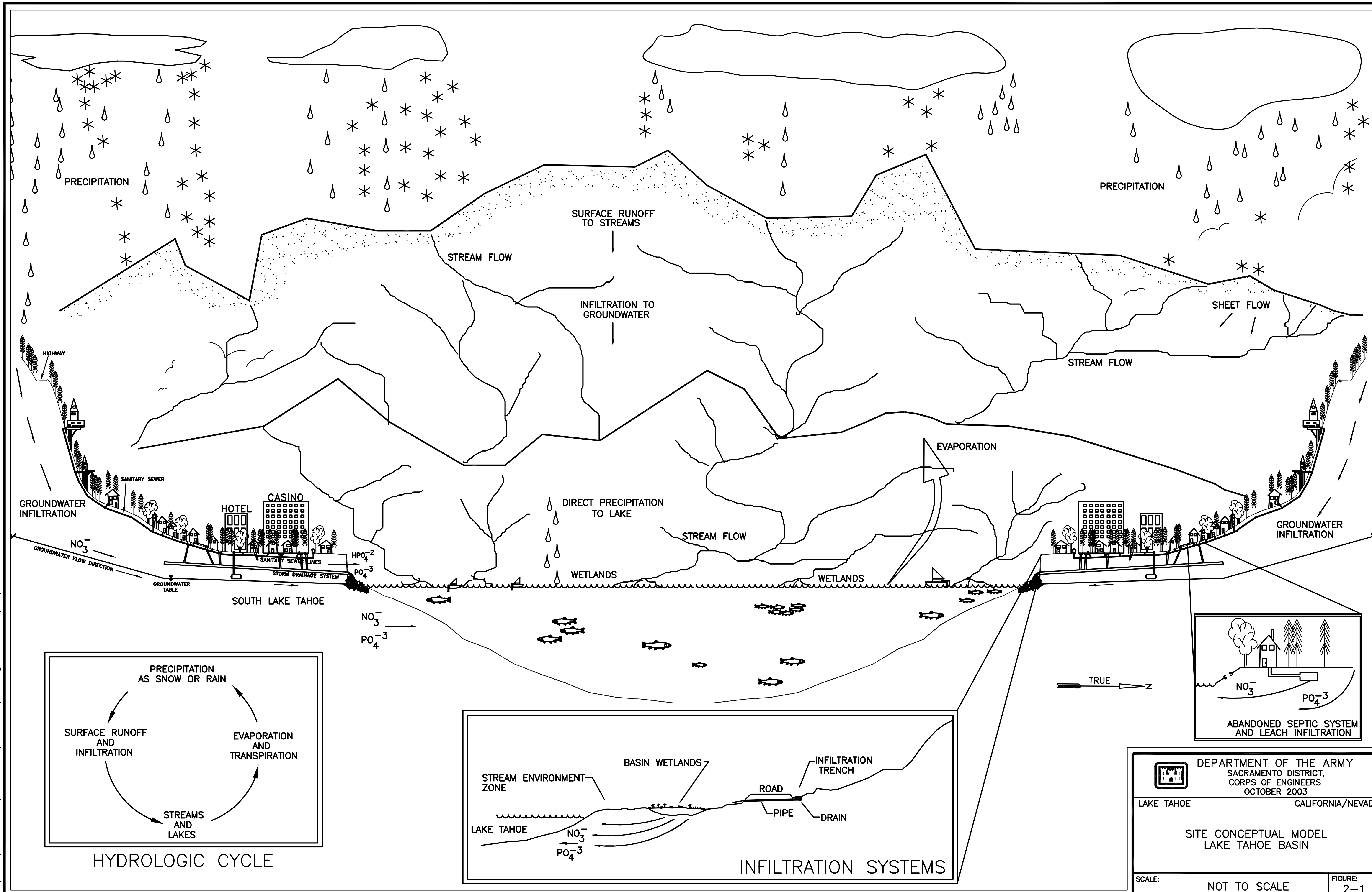
A conceptual site model for this evaluation was developed as an aid in explaining applicable chemical reactions of nitrogen and phosphorous, sources of those nutrients, the mediums through which nutrients are driven to the groundwater, and the pathways that the nutrients can take to reach the lake. A brief description of the hydrologic cycle is provided below as an aid in developing a conceptual site model of groundwater behavior in the Tahoe Basin.

- Water vapor trapped in clouds precipitates as snow and rain.
- Surface runoff and groundwater discharge to rivers, streams, and eventually the lake.
- Evaporation and transpiration return water to the vapor state and complete the hydrologic cycle (Figure 2-1).

The dramatic topographic relief of the surrounding watersheds limits urban development to a few flat areas along streams and in wetlands. Two recent studies in the Tahoe Basin estimate groundwater flow into Lake Tahoe at a rates of about 3.7 x 10^7 m^3/year (30,000 acre-feet per year) (Fogg 2002) and 4.9 x 10^7 m^3/year (40,000 acre-feet per year) (Thodal 1997). Surface runoff flows into streams while groundwater infiltrates basin fill and fractured bedrock, with both eventually discharging to Lake Tahoe. The only outlet from Lake Tahoe is the Truckee River, which flows northeast from the lake through Reno, Nevada, and finally into Pyramid Lake.

Rainfall and snowmelt infiltrate the upland basin fill deposits and fractured rock. As groundwater infiltrates and travels downgradient, it passes through developed areas and co-mingles with infiltration from lower areas. Along the way, groundwater may be enriched with soluble nutrients through various processes. Among the major sources of these soluble nutrients are storm water infiltration basins, runoff from golf courses and parking lots, runoff from housing developments, and sewage and septic systems.

Historically, Lake Tahoe has maintained an oligotrophic state because it received very low amounts of nutrients and sediments. The lake has been both nitrogen- and phosphorus-limited. Logging during the last half of the nineteenth century caused a temporary decrease in clarity, but the lake recovered over a period of about 50 years (Heyvaert 1998). Starting around 1960, nitrogen loading from vehicle emissions and dissolved fertilizer created a high nitrogen to phosphorus ratio and caused the lake to shift to being phosphate-limited by about 1980 (Jassby et al. 2001). As expected in the eutrophication process, the flora and fauna of the lake are increasing in both population and diversity as a result of nutrient loading. Figure 2-1 illustrates a conceptual site model of groundwater and nutrient movement in the Tahoe Basin. The figure also includes detailed sketches of the hydrologic cycle, an abandoned septic system and its associated leach field, and an engineered infiltration system.



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT,
CORPS OF ENGINEERS
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LAKE TAHOE — CALIFORNIA/NEVADA

SITE CONCEPTUAL MODEL
LAKE TAHOE BASIN

SCALE: NOT TO SCALE

FIGURE: 2-1

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